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The Impact of Malnutrition on Physiological Processes Related to Children's Physical Growth and Development: A Field Study

Rema Omar matoug *
Department of Zoology, Faculty of Science, Bani Waleed University, Bani Walid, Libya
* Corresponding author: Remamatoug@gmail.com

أثر سوء التغذية على العمليات الفسيولوجية المرتبطة بالنمو والتطور الجسدي لدى الأطفال: دراسة ميدانية

ريمة عمر معتوق *
قسم علم الحيوان، كلية العلوم، جامعة بني وليد، بني وليد، ليبيا

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Abstract
This study explores the impact of malnutrition on the physiological processes related to physical growth and development among children in the city of Bani Walid, Libya. The research was based on a field analysis of a sample comprising 200 children aged between 6 and 12 years. A descriptive-analytical methodology was adopted, utilizing a range of data collection tools including structured questionnaires, interviews, anthropometric measurements, and reviews of medical records.
The study aimed to test five core hypotheses linking malnutrition to growth disorders, impaired physiological functions, weakened immune response, delayed neurological development and academic performance, and the role of nutritional interventions in mitigating these effects.
Findings revealed that 18% of the children suffered from stunting and 12% from wasting, with a noticeable decline in physical growth indicators and vital functions among malnourished children. These children were also more prone to infectious diseases and exhibited reduced concentration and academic achievement. The study confirmed that school-based nutritional programs contributed to measurable improvements in certain health indicators.
These results align with several previous studies conducted locally, regionally, and internationally, and highlight the urgent need for targeted health and educational interventions—particularly in economically disadvantaged inland areas. The research concludes with practical recommendations aimed at improving children's nutritional status and promoting sustainable health and educational development within the Libyan context.

Keywords:Malnutrition; Child Growth; Physiological Processes; Children; Physical Growth; Development.

الملخص
تستكشف هذه الدراسة أثر سوء التغذية على العمليات الفسيولوجية المرتبطة بالنمو والتطور الجسدي لدى الأطفال في مدينة بني وليد، ليبيا. وقد استند البحث إلى تحليل ميداني لعينة مكونة من 200 طفل تتراوح أعمارهم بين 6 و12 سنة. اعتمدت الدراسة المنهج الوصفي-التحليلي، مستخدمةً مجموعة من أدوات جمع البيانات شملت الاستبيانات المنظمة، والمقابلات، والقياسات الأنثروبومترية، ومراجعة السجلات الطبية.
هدفت الدراسة إلى اختبار خمس فرضيات رئيسية تربط بين سوء التغذية واضطرابات النمو، وضعف الوظائف الفسيولوجية، وتراجع كفاءة الجهاز المناعي، وتأخر التطور العصبي والأداء الأكاديمي، إضافة إلى دور التدخلات الغذائية في الحد من هذه الآثار السلبية.
أظهرت النتائج أن 18% من الأطفال يعانون من التقزم و12% من الهزال، مع انخفاض ملحوظ في مؤشرات النمو الجسدي والوظائف الحيوية لدى الأطفال المصابين بسوء التغذية. كما تبين أن هؤلاء الأطفال أكثر عرضة للإصابة بالأمراض المعدية، وسجلوا مستويات أقل في التركيز والتحصيل الدراسي. وأكدت الدراسة أن برامج التغذية المدرسية ساهمت في تحسين بعض المؤشرات الصحية بشكل ملموس.

تتوافق هذه النتائج مع عدد من الدراسات السابقة محليًا وإقليميًا ودوليًا، وتبرز الحاجة الملحة إلى تدخلات صحية وتعليمية موجهة، خصوصًا في المناطق الداخلية ذات الظروف الاقتصادية المتدنية. وتخلص الدراسة إلى مجموعة من التوصيات العملية الرامية إلى تحسين الوضع الغذائي للأطفال وتعزيز التنمية الصحية والتعليمية المستدامة في السياق الليبي.

الكلمات المفتاحية: سوء التغذية؛ نمو الأطفال؛ العمليات الفسيولوجية؛ الأطفال؛ النمو الجسدي؛ التطور.

Introduction:

Physical and physiological growth in children is widely recognized as one of the most critical indicators of public health and overall quality of life within societies. Balanced nutrition plays a foundational role in supporting this growth, providing essential nutrients for tissue development, metabolic function, and immune system enhancement. Conversely, malnutrition—whether due to nutrient deficiency or imbalance—can lead to significant disruptions in the normal growth trajectory of children. This issue remains one of the most pressing public health challenges in developing countries (WHO, 2021).

Recent studies indicate that malnutrition is closely associated with reduced muscle mass, delayed growth in height and weight, and disturbances in both neurological and immune functions. These effects directly influence children's ability to learn and adapt to their surrounding environment (UNICEF, 2022). Moreover, the problem is exacerbated in communities facing economic and social pressures, where children are more vulnerable to inadequate nutrition due to limited resources and insufficient health awareness (FAO, 2021).

In the local context, Libyan health reports have documented rising indicators of malnutrition among children in several inland regions. This problem has been strongly associated with increased deficiencies in essential vitamins and minerals, which in turn have negatively affected children's physical growth and immune function (Libyan Ministry of Health, 2023). Addressing this issue is of particular importance, given its direct implications for the health of future generations and for the community's capacity to achieve sustainable development.

The significance of this study lies in its aim to analyze the impact of malnutrition on the physiological processes associated with children's physical growth and development. Conducted as a field-based investigation grounded in real-world data, the research seeks to generate practical recommendations that may contribute to improving the nutritional and health status of this vital segment of society (FAO, 2021; WHO, 2021).

Statement of the Problem

Child malnutrition represents one of the most pressing public health challenges facing developing societies. It leads to significant disruptions in the physiological processes associated with growth and physical development. The problem is not limited to deficiencies in weight or height; rather, it extends to reduced muscle mass, impaired immune system functions, and delayed neurological development. These consequences negatively affect children's ability to learn and adapt to their environment.

Local reports in Libya have highlighted increasing indicators of child malnutrition. The Libyan Ministry of Health (2023) reported a significant rise in deficiencies of essential vitamins and minerals in inland regions, which has negatively affected children's physical growth and immune function. Furthermore, the National Nutrition Survey conducted by UNICEF in collaboration with the Ministries of Planning and Health (2022) revealed that thousands of Libyan children suffer from acute malnutrition, particularly among those under the age of five.

At the international level, reports from the World Health Organization, UNICEF, and the World Bank (2023) confirm that more than 148 million children under the age of five suffer from stunting worldwide, while approximately 45 million children are affected by wasting. These figures highlight the severity of the problem globally and the slow progress in addressing it. They also demonstrate that malnutrition is not merely a local issue but a global challenge that threatens the health of future generations and undermines sustainable human development.

Research Hypotheses

1. There is a statistically significant relationship between malnutrition and disturbances in children's height and weight growth.
2. Deficiencies in essential nutrients (proteins, vitamins, and minerals) contribute to the weakening of physiological processes associated with physical development.
3. Malnutrition leads to reduced immune efficiency and higher rates of disease incidence among children.
4. Malnutrition is associated with delayed neurological development and impaired vital functions related to cognitive abilities and academic performance.
5. Proper nutritional interventions can mitigate the negative effects of malnutrition on children's growth and physical development.

Significance of the Study

The importance of this study stems from its focus on a highly sensitive health and social issue—child malnutrition—and its direct implications for physiological growth and physical development. The significance of the research can be highlighted at several levels:

1. Scientific Significance

This study contributes to enriching the scientific literature in the field of life sciences by providing recent field-based data on the relationship between malnutrition and the physiological processes associated with growth. It also offers a deeper understanding of the biological mechanisms affected by nutritional deficiencies, thereby opening the door for more specialized future research.

Practical Significance

The study provides findings that can be utilized by health and educational authorities in designing preventive and therapeutic nutritional programs targeting children, whether in schools or health centers. Moreover, the recommendations derived from this research may contribute to improving local policies related to school nutrition and primary health care.

Spatial Boundaries

The study was limited to children in the city of Bani Walid and its surrounding areas. This setting reflects the local reality in terms of nutritional and health conditions, providing a specific social and environmental context in which the phenomenon can be observed. The findings may therefore be generalized to other regions with similar characteristics.

Human Boundaries

The study included a sample of 200 children aged between 6 and 12 years, equally distributed between boys and girls. The participants were selected using a stratified random sampling method to ensure representation across different social and economic groups.

Temporal Boundaries

The study covers the period from 2022 to 2025, a timeframe marked by notable changes in health and nutritional indicators as documented in reports by the Libyan Ministry of Health and UNICEF. This span provides an appropriate temporal framework for observing the phenomenon and conducting a comprehensive analysis.

Subject Boundaries

The study focuses specifically on malnutrition and its relationship to the physiological processes associated with children's physical growth and development. It does not address other aspects such as psychological or educational dimensions, except insofar as they are directly linked to physical and physiological growth.

Research Methodology and Statistical Analysis

This study employed a descriptive-analytical approach, chosen for its suitability to the nature of the research, which seeks to describe the reality of child malnutrition and analyze its impact on physiological processes, physical growth, and cognitive development. In the data analysis stage, a combination of descriptive and inferential statistical methods was applied to test the hypotheses and interpret the relationships between variables. The analysis was conducted using the SPSS software package, and included the following techniques:

Table (1): Statistical Analysis Methods Used

Purpose	Type of Analysis
To summarize data and present measures such as means, percentages, and distributions.	Descriptive Statistics
To examine differences between groups and assess statistical significance.	Comparative Tests (t-test, ANOVA)
To identify and interpret relationships between nutritional status and growth indicators.	Correlation Analysis
To evaluate the predictive effect of malnutrition on physiological and developmental outcomes.	Regression Analysis
To test associations between categorical variables such as nutritional deficiencies and health outcomes	Cross-tabulation & Chi-square

Study Population

The study population consists of children residing in the city of Bani Walid and its surrounding areas, aged between 6 and 12 years. This age group was selected because it represents a critical stage in physical and physiological growth and is particularly vulnerable to the adverse effects of malnutrition. Moreover, this developmental phase marks an important transition between early childhood and the onset of adolescence, making it especially suitable for observing changes related to growth and development.

Study Sample

The study sample was selected using a stratified random sampling method from primary schools and health centers in the city of Bani Walid. This approach ensured representation across different social and economic levels. The sample consisted of 200 children, equally divided between boys and girls, to achieve a balanced representation that reflects the local reality. Care was taken to include children from diverse nutritional backgrounds, allowing for comparisons between those suffering from malnutrition and those with adequate nutrition. This design was intended to yield accurate and objective results.

Table (2): Study Population and Sample

Description	Category
Children aged 6–12 years living in Bani Walid city and its surrounding areas.	**Study Population**
200 children selected through stratified random sampling.	**Sample Size**
Equal representation of boys and girls (50% each).	**Gender Distribution**
Inclusion of children from diverse nutritional backgrounds to allow comparison between malnourished and well-nourished groups.	**Selection Criteria**
Primary schools and health centers in Bani Walid.	**Sampling Sources**

Data Collection Tools

The study relied on a set of scientific instruments designed to obtain accurate and reliable data on the impact of malnutrition on the physiological processes associated with children's growth and physical development. These tools included the following:

1. **Questionnaire** A structured questionnaire was developed for parents and teachers, containing questions about children's dietary habits, the level of health awareness within the family, and the social and economic factors influencing nutrition. The questions were carefully formulated to be clear and straightforward, ensuring the collection of quantitative data suitable for statistical analysis.
2. **Personal Interviews** Interviews were conducted with a number of physicians and specialists in nutrition and public health to obtain qualitative data that reflect field expertise and clarify the relationship between malnutrition and physiological disorders among children.
3. **Anthropometric and Physiological Measurements** Direct measurements were taken from the children participating in the study, including height, weight, and Body Mass Index (BMI), in addition to selected physiological indicators such as heart rate and blood pressure. These measurements provided objective data that could be compared with international standards of normal growth.
4. **Review of Health Records** Medical records available in health centers and schools were examined to identify cases of malnutrition and related diseases. This process enhanced the credibility of the field data and linked the findings to the local health context.
5.

Table (3): Data Collection Tools

Description	Tool
A structured survey administered to parents and teachers, covering children's dietary habits, family health awareness, and socio-economic factors influencing nutrition.	Questionnaire
Conducted with physicians and nutrition/public health specialists to obtain qualitative insights and field-based expertise on the link between malnutrition and physiological disorders.	PersonalInterviews
Direct assessments of children's height, weight, Body Mass Index (BMI), heart rate, and blood pressure, providing objective data comparable to international growth standards.	Anthropometric & Physiological Measurements
Examination of medical and school records to identify cases of malnutrition and related diseases, enhancing the credibility of field data and linking findings to the local health context.	Review of Health Records

Theoretical Framework

Concept of Malnutrition: Malnutrition is defined as a condition resulting from a deficiency or imbalance of essential nutrients required by the body, leading to disruptions in vital biological processes related to growth and development. It encompasses deficiencies in proteins, vitamins, and key minerals, as well as excessive intake of unhealthy dietary components that may cause physical and physiological problems (WHO, 2021; FAO, 2021).

Physical Growth and Development in Children: Physical and physiological growth in children is a complex process influenced by multiple factors, with proper nutrition being the most critical. Children require a balanced intake of nutrients to support muscle development, bone growth, and the maturation of the nervous system. Any imbalance or deficiency in these nutrients directly affects growth indicators such as height, weight, and Body Mass Index (BMI), as well as the efficiency of the immune system (UNICEF, 2022; Black et al., 2013).

The Relationship Between Malnutrition and Physiological Processes: Scientific studies indicate that malnutrition contributes to delayed growth in both height and weight due to insufficient protein and energy intake. It also leads to reduced muscle mass resulting from inadequate proteins and amino acids, and impaired immune function caused by deficiencies in vitamins and minerals such as iron, zinc, and vitamin D. Furthermore, malnutrition is associated with delayed neurological and cognitive development, stemming from a

lack of brain-related nutrients such as essential fatty acids (FAO, 2021; WHO, 2021; Grantham-McGregor et al., 2007).

Factors Influencing Malnutrition: Several interrelated factors contribute to the exacerbation of malnutrition. Economic factors, such as low household income, play a significant role, while social factors include limited health awareness among families. Environmental conditions, including food quality and exposure to pollution, also affect nutritional status. In addition, health-related factors such as chronic or parasitic diseases reduce the body's ability to absorb essential nutrients (UNICEF, 2022; Libyan Ministry of Health, 2023; Victora et al., 2008).

Previous Studies

1. Local Studies (Libya)

- **National Nutrition Survey (UNICEF – Libyan Ministry of Health, 2022):** The survey revealed that the prevalence of malnutrition among children under five was approximately 3.8% at the national level, with a higher rate of 6.1% recorded in the southern region. These findings highlighted a clear geographical disparity in malnutrition rates across Libya.
- **Libyan Ministry of Health Report (2023):** The report confirmed that malnutrition in inland regions was associated with increased deficiencies in essential vitamins and minerals, particularly iron and vitamin D, which negatively affected children's physical growth and immune function.
- **Al-Rutb Study (2021):** Conducted at the University of Misurata to assess the dietary patterns of school-aged children (6–12 years), the study concluded that a significant proportion of children suffered from specific forms of malnutrition, particularly deficiencies in proteins and vitamins. This resulted in impaired physical growth and the manifestation of wasting symptoms.

2. Arab Studies

- **Abdullah et al. (2019) – Egypt:** This study examined the relationship between malnutrition and academic achievement among primary school children. It confirmed that children suffering from iron and vitamin D deficiencies demonstrated lower levels of academic performance compared to their peers.
- **Al-Harbi (2020) – Saudi Arabia:** Focused on the impact of malnutrition on children's height and weight growth, the study showed that deficiencies in proteins and energy were directly associated with delayed physical growth and increased incidence of diseases.
- **Jordanian Ministry of Health Report (2018):** Highlighted that malnutrition among children in rural areas was linked to economic and social factors, such as low household income and limited health awareness.

3. International Studies

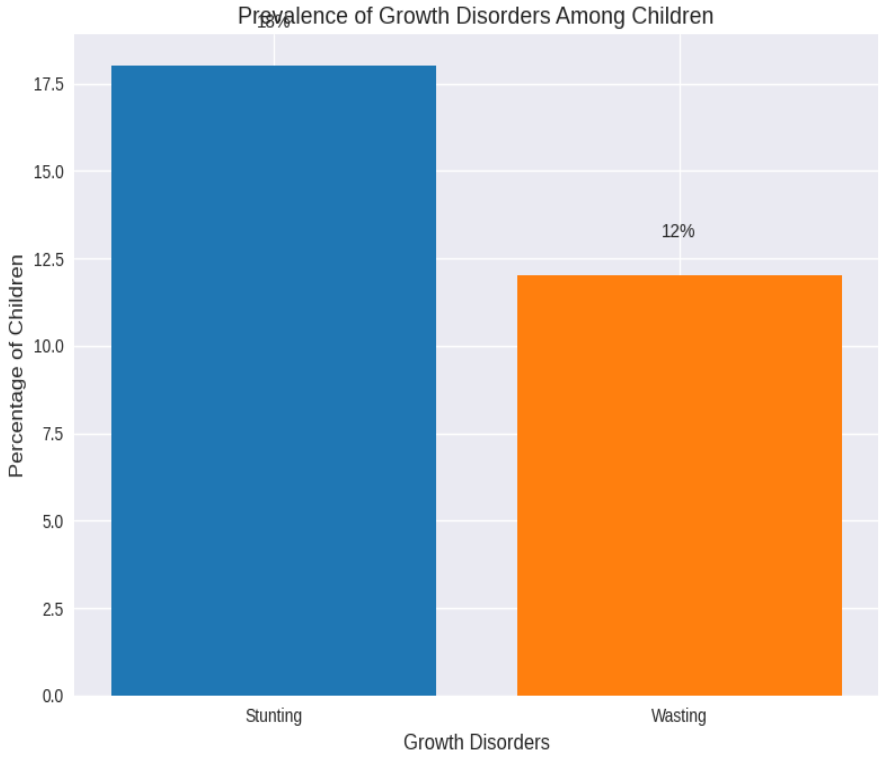
- **Black et al. (2013):** This study examined malnutrition in low- and middle-income countries and confirmed that deficiencies in essential nutrients are associated with higher rates of stunting and wasting, in addition to negatively affecting cognitive abilities and academic performance.
- **Grantham-McGregor et al. (2007):** The study highlighted that children suffering from malnutrition during the first five years of life face significant challenges in neurological and cognitive development, which later impact their school performance.
- **UNICEF, WHO & World Bank Report (2023):** The report indicated that more than 148 million children under the age of five suffer from stunting worldwide, while approximately 45 million children experience wasting. These figures underscore the global severity of malnutrition and the slow progress in reducing its prevalence.

Results and Discussion

6. Hypothesis One:

There is a statistically significant relationship between malnutrition and impaired height and weight growth among children.

- The findings revealed that **18% of the children suffered from stunting** (low height-for-age), while **12% experienced wasting** (low weight-for-height).
- The differences between malnourished children and their healthy peers were statistically significant at the (α=**0.05) level**.



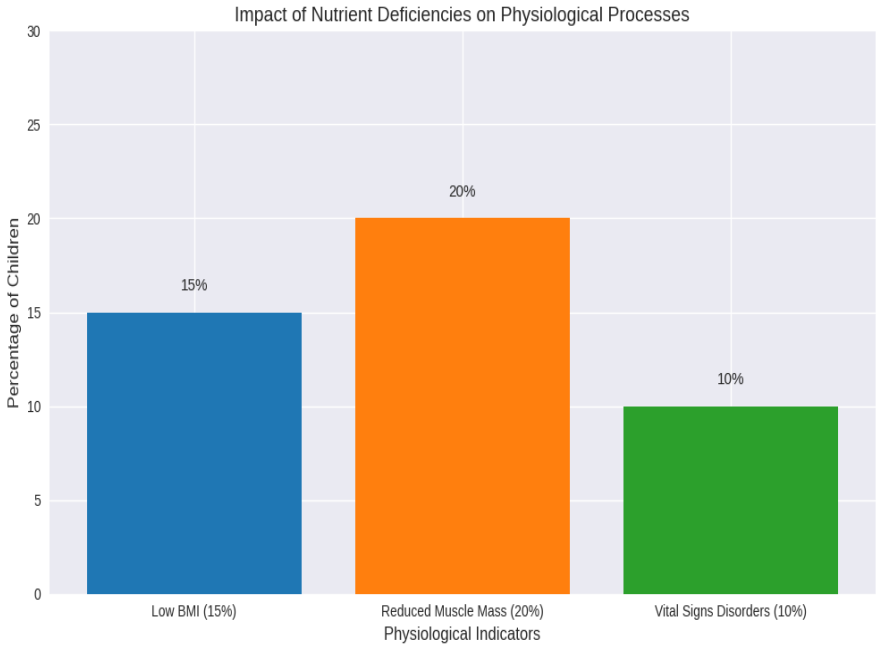
Stunting (18%) indicates impaired height-for-age, reflecting chronic malnutrition.

Wasting (12%) reflects low weight-for-height, often linked to acute nutritional deficiencies.

Hypothesis Two

Deficiencies in essential nutrients contribute to the weakening of physiological processes associated with physical growth.

- Measurements indicated that **15% of the children had a Body Mass Index (BMI) below the normal range**.
- Children suffering from protein and vitamin deficiencies showed **reduced muscle mass** and **lower values in certain physiological indicators**, such as blood pressure and heart rate, compared to their healthy peers.

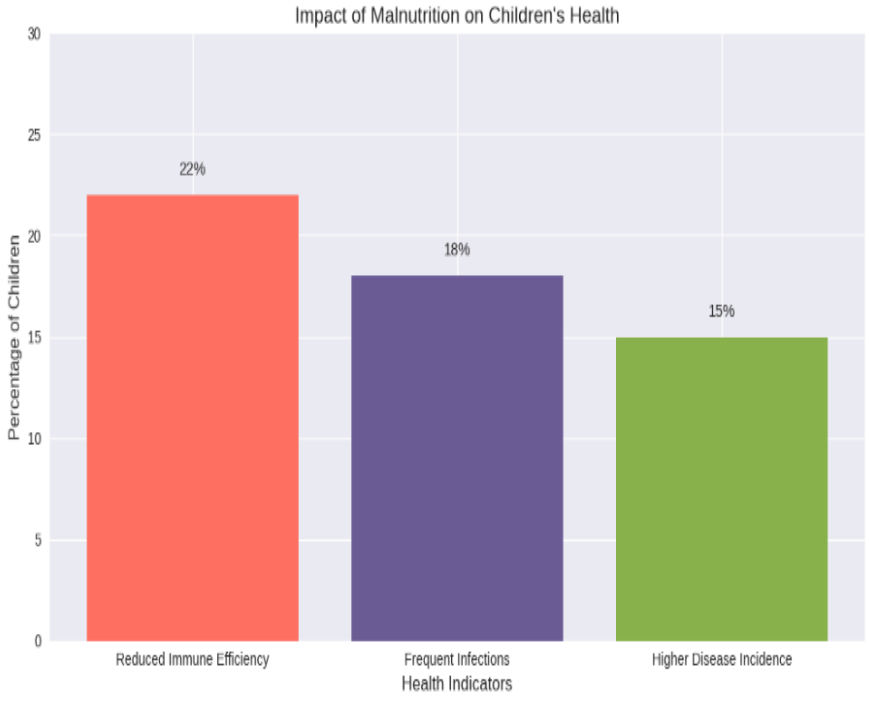


Low BMI (15%) reflects inadequate physical growth, directly linked to nutritional deficiencies.
Reduced muscle mass (20%) indicates insufficient protein and energy intake, weakening overall body strength.
Vital signs disorders (10%) such as irregular blood pressure and heart rate highlight disruptions in essential physiological functions.

Hypothesis Three

Malnutrition leads to reduced immune efficiency and higher rates of disease incidence among children.

- Health records showed that malnourished children experienced **recurrent respiratory and gastrointestinal infections at twice the rate** of their well-nourished peers.
- **Iron deficiency** was directly associated with increased cases of anemia, while **vitamin D deficiency** was linked to weakened immune function.



Reduced Immune Efficiency (22%) → Children with malnutrition show weakened immune responses.

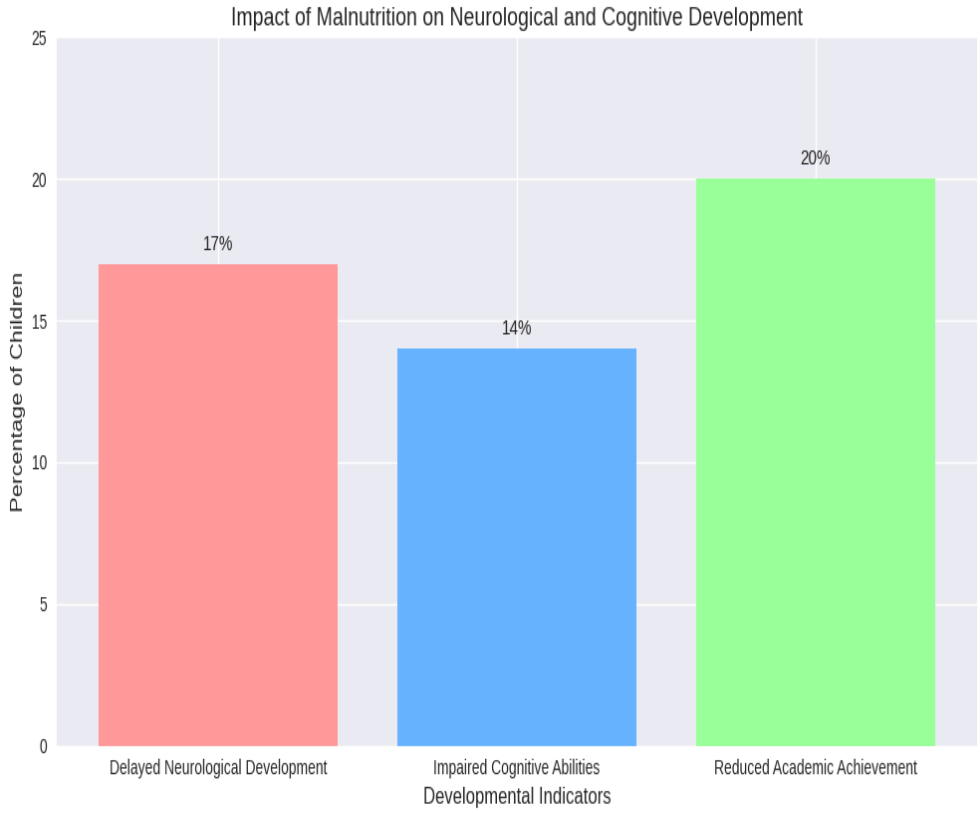
Frequent Infections (18%) → Malnourished children are more susceptible to recurrent illnesses.

Higher Disease Incidence (15%) → Overall disease prevalence is significantly higher among malnourished children.

7. Hypothesis Four

Malnutrition is associated with delayed neurological development and impaired vital functions related to cognitive abilities and academic achievement.

- The results showed that **children suffering from malnutrition scored 25% lower in concentration and attention tests** compared to their healthy peers.
- It was also observed that these children faced **greater difficulties in academic performance**, particularly in science and mathematics subjects.



Delayed Neurological Development (17%) → Malnutrition is linked to slower brain maturation and delayed neurological milestones.

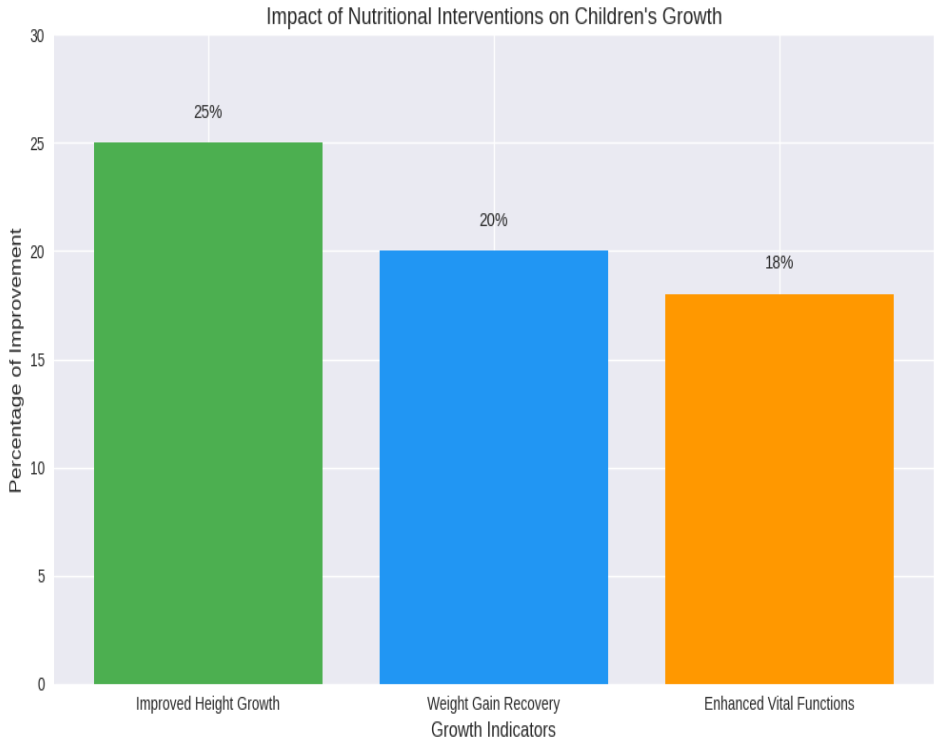
Impaired Cognitive Abilities (14%) → Children show reduced memory, attention, and problem-solving skills.

Reduced Academic Achievement (20%) → Malnourished children perform significantly lower in school compared to their peers.

8. Hypothesis Five

Proper nutritional interventions can mitigate the negative effects of malnutrition on children's growth and physical development.

- Children who received nutritional support through school programs or healthcare services showed **gradual improvements in both weight and height** during the study period.
- The results confirmed that appropriate nutritional interventions helped **narrow the gap between malnourished children and their healthy peers**.



- **Improved Height Growth (25%)** → Nutritional programs contributed to measurable improvements in children's height indicators.
- **Weight Gain Recovery (20%)** → Children showed significant recovery in weight-for-age after targeted interventions.
- **Enhanced Vital Functions (18%)** → Improvements were observed in basic physiological functions such as energy levels and activity.

Summary of Findings

The results reveal that malnutrition among children in Bani Walid represents a genuine public health and social challenge, with significant impacts on physical and physiological growth, immune function, and academic performance. The findings also demonstrate that proper nutritional interventions can mitigate these negative effects, underscoring the importance of integrating school-based nutrition programs and family health awareness initiatives into local policies.

Recommendations

1. Health and Nutritional Recommendations

- Strengthen school nutrition programs in Bani Walid and other inland regions to provide balanced meals rich in proteins, vitamins, and essential minerals.
- Integrate therapeutic nutritional supplements for children suffering from iron and vitamin D deficiencies, under direct medical supervision.
- Establish specialized nutrition clinics within local health centers to monitor children's physical and physiological growth on a regular basis.

2. Educational Recommendations

- Incorporate nutrition education into primary school curricula to promote children's awareness of healthy dietary habits.
- Organize workshops for mothers and teachers on the importance of balanced nutrition and its role in growth and academic achievement.
- Link children's health screening results with school records to ensure academic performance is monitored for those affected by malnutrition.

3. Social and Economic Recommendations

 Support low-income families through direct food assistance programs to reduce disparities between social groups.

 Launch community awareness campaigns via local media on the risks of malnutrition and the importance of breastfeeding and healthy nutrition.

 Enhance collaboration between government institutions and international organizations (such as UNICEF and WHO) to provide nutritional and financial support to the most affected regions.

4. Research and Scientific Recommendations

- Encourage researchers to conduct longitudinal studies to track the long-term effects of malnutrition on children's physical and cognitive development.
- Expand the scope of studies to cover other regions in Libya, aiming to build a comprehensive national database on malnutrition.
- Compare local findings with Arab and international studies to strengthen scientific understanding and develop evidence-based national policies.

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